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Mutli-analyser Option for Thermal-neutron Triple-axis Spectrometer Taipan Future Upgrading

Guochu Deng,[1,*] Kirrily Rule[1], Anton Stampfl[1], and Garry J McIntyre[1]

[1] Australian Centre for Neutron Scattering, Australian Nuclear Science and Technology Organisation, New Illawarra Road, Lucas Heights NSW 2234, Australia

Abstract

Taipan is a high-flux thermal-neutron triple-axis spectrometer with a traditional single-detector design. Taipan has been the power horse for thermal-neutron inelastic neutron scattering experiments at ACNS for the last ten years, generating numerous beautiful scientific highlights. Following the current trend for the neuron instrumentation worldwide, it is interesting to consider a future upgrade of Taipan to increase its data acquisition efficiency with a multi-analyser design. In this research, the possibility of upgrading Taipan into a multi-analyser triple-axis spectrometer is discussed. The simulation of the 21 analyser channels with a 2° gap in-between is demonstrated. The simulated result shows that the data acquisition efficiency can be substantially enhanced on Taipan and the multi-analyser design is also very suitable for magnetic diffraction measurement at the low Q range.

Introduction to Taipan

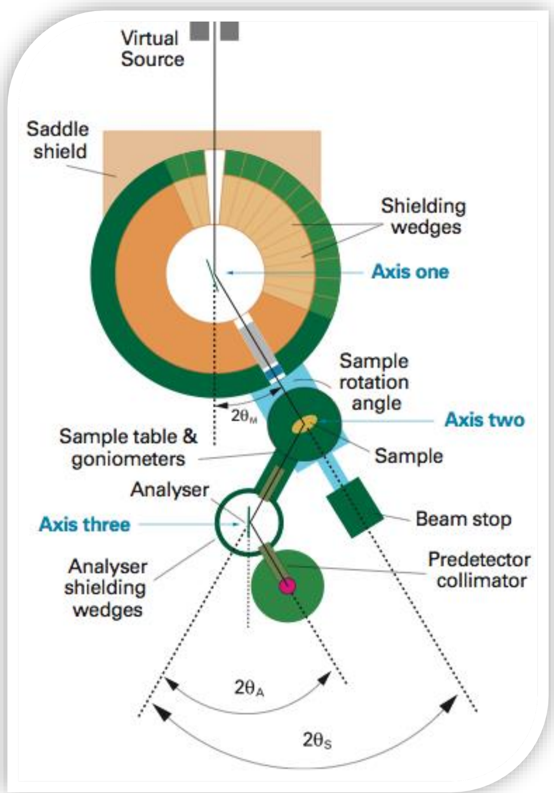

Fig. 1 The schematics of Taipan configuration.

Taipan is a thermal-neutron triple-axis spectrometer (TAS) with the traditional single-detector design. Its double focusing monochromator is able to provide high neutron flux at the sample position, which makes Taipan the power horse for users' inelastic neutron experiments at ACNS.[1]

However, the single-detector design significantly limits the data acquisition efficiency. Large amounts of scattered neutrons, which carry the sample excitation information, are wasted. It is time to consider to upgrade Taipan into a multi-analyser TAS for higher data acquisition efficiency.

Taipan Specification:

Monochromator:	PG(002) or Cu(200), DF
Analyser:	PG(002) , DF
Take-off angle $2\theta_M$:	16°~85°
Sample scattering $2\theta_S$:	-128°~95°
Analyser angle $2\theta_A$:	-110°~110°
Pre-mono collimator:	open, 15', 30'
Pre-sample collimator:	open, 20', 40', 60'
Incident Energy:	5~120meV
Energy Transfer:	0~100meV
Energy Resolution:	0.5~1.0meV (E_f=14.87meV)

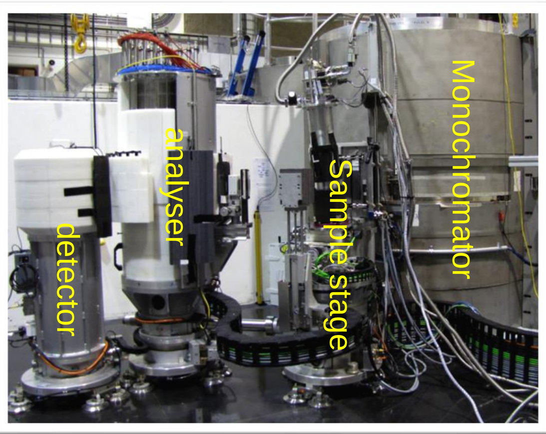

Fig. 2 Photo of the current Taipan

Design of Multi-analyser

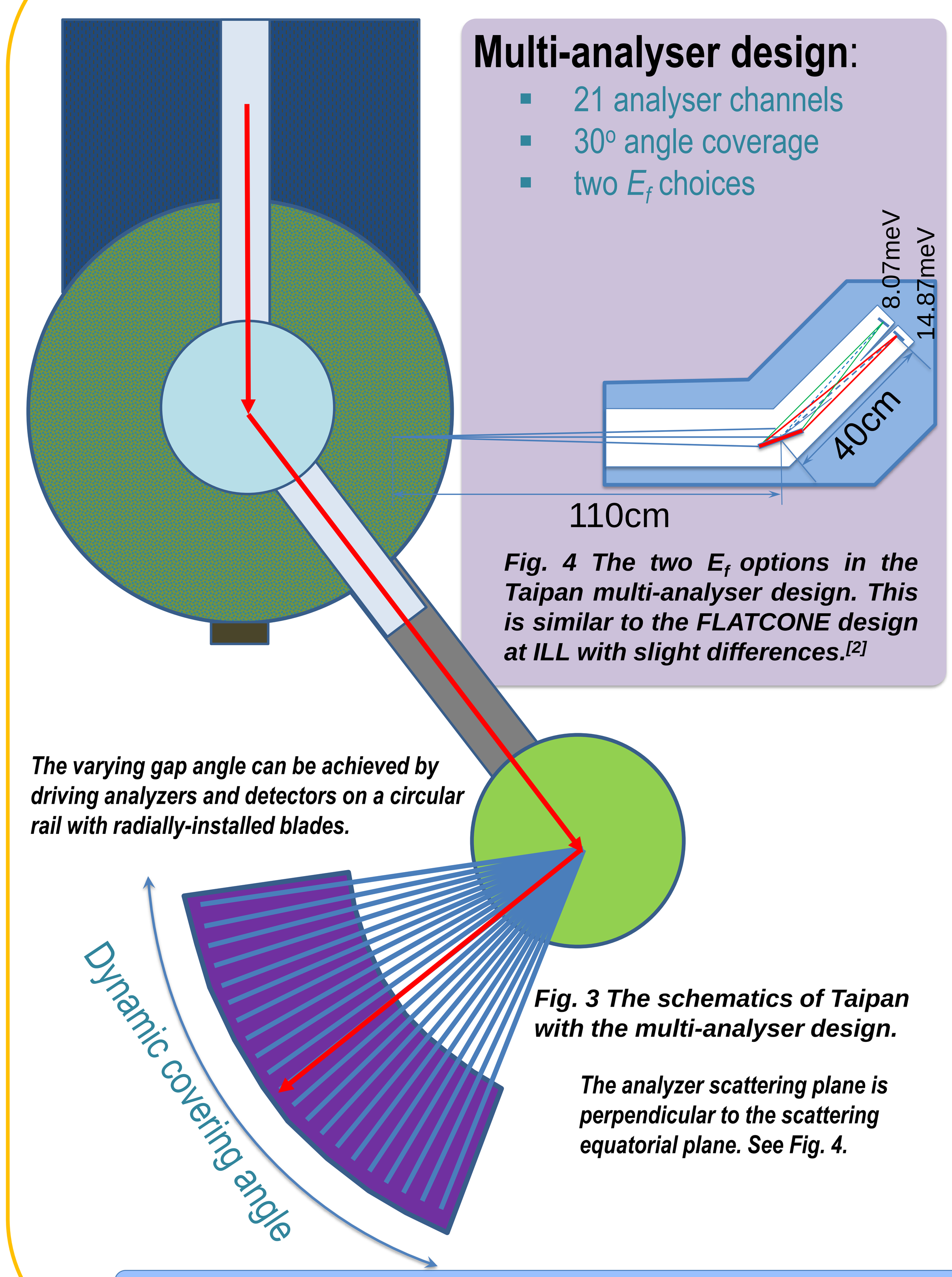

Fig. 4 The two E_f options in the Taipan multi-analyser design. This is similar to the FLATCONE design at ILL with slight differences.[2]

Fig. 3 The schematics of Taipan with the multi-analyser design.

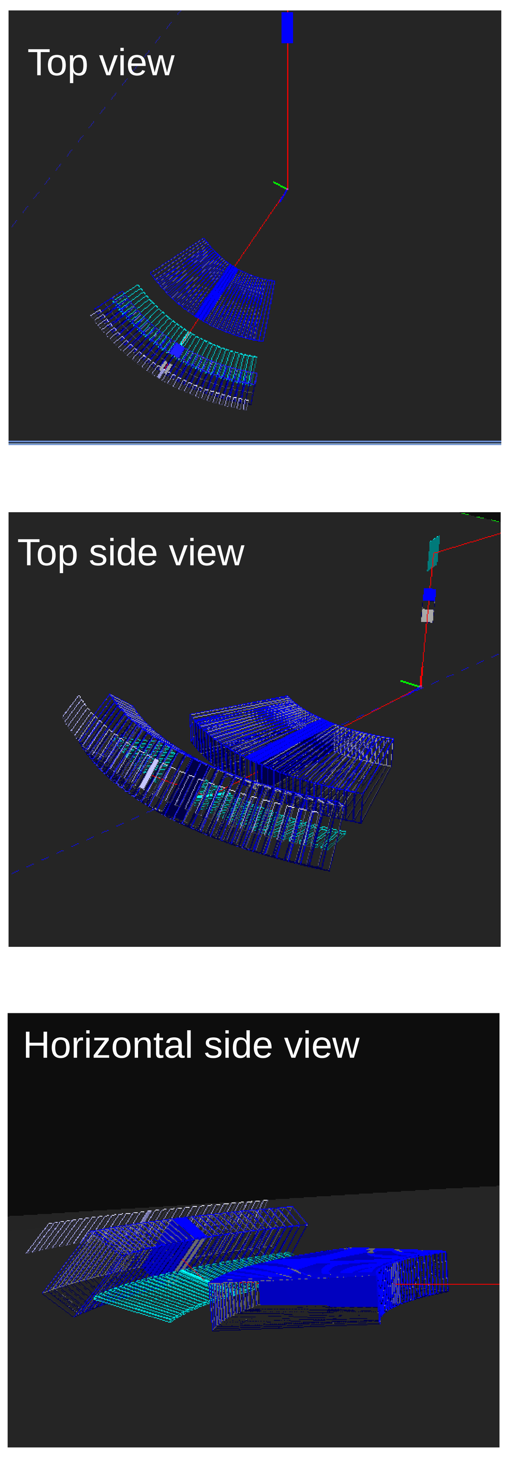

Fig. 5 The geometric design of the Taipan multi-analyser for the simulation.

Scattering angle distribution options: 1.5, 2.0, 2.5 degree

Simulation of Multi-analyser Design on Taipan

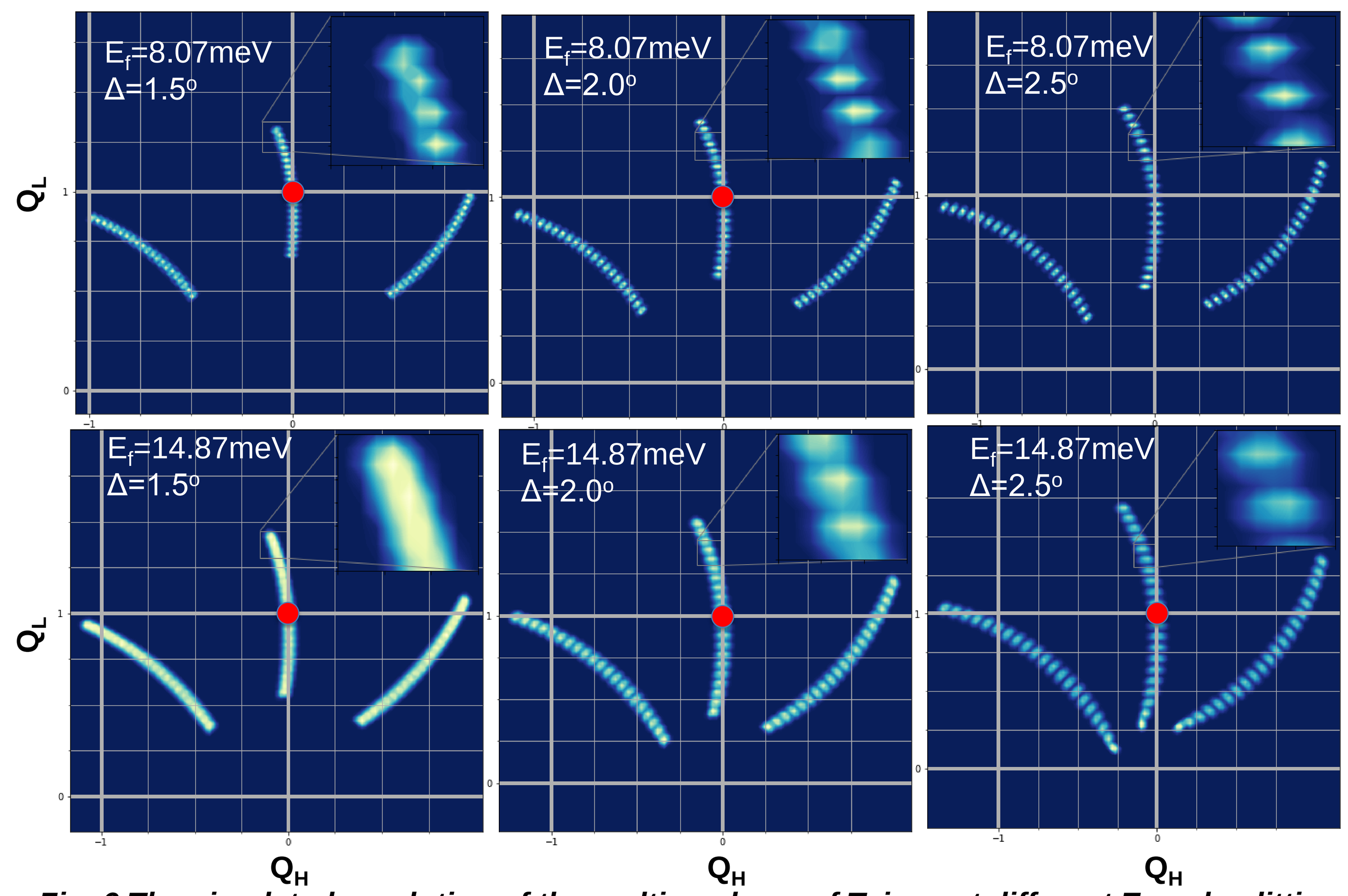

Fig. 6 The simulated resolution of the multi-analyser of Taipan at different E_f and splitting angle Δ near Q(0 1 0) of a dummy crystal (3.85, 3.85, 12.73, 90, 90, 90). The Q positions are marked as red dots. The simulation was performed by using Restrax[3]*.*

The above results shows that the splitting angle Δ of 2° is quite good enough for the final energy of 8.07 and 14.87meV. If the splitting angle is 1.5°, all the data from the channels will form a continuous bar without gaps at E_f=14.87meV. In this configuration, Taipan will be very good to do the elastic/diffraction mapping, while it is not good for the inelastic survey over a large area. For Δ =2.0°, the signals from each channel are just distinguishable, which combines the data acquisition efficiency and the quality of data. With Δ=2.5°, the gap between neighbour channels are quite large, which is good for wide Q range survey for both Ef. A dynamic design of the splitting angle will be a fascinating feature for the multi-analyser upgrade of Taipan.

Comparing with Multiplexing Mode on Sika

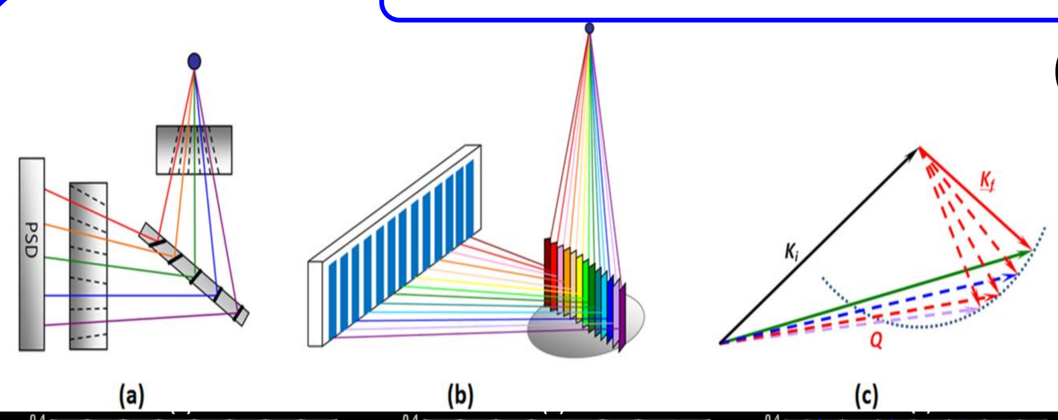

Fig. 7(a) Schematic diagram of Multi-Q Constant E_f mode on Sika[3, 4] *The analyzer scattering in the same way as the traditional TAS in the equatorial plane.*

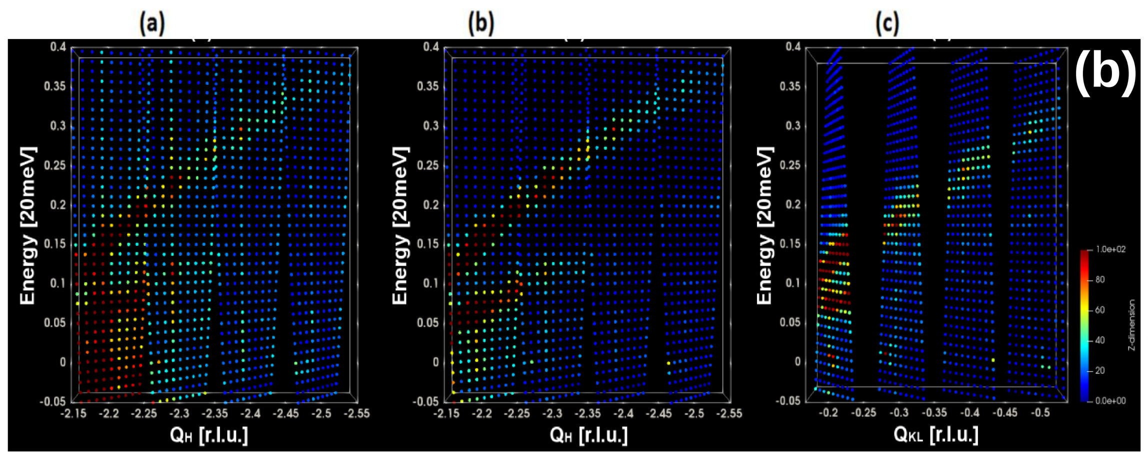

Fig. 7(b) The longitudinal and transverse phonon dispersions of Pb measured with the above mode near Q(200)[4]

Sika multiplexing mode demonstrates that it is possible to map one phonon dispersion branch with 4 scans and 45 q points. Considering Taipan multi-analyser design has 21 channels while Sika has 9 channels, it is possible to measure the same dispersion with only one scan or two scans with Δ=2.0°. See the q range coverage in Fig. 5. above. This means much higher data acquisition efficiency.

Summary

A new multi-analyser design for the thermal-neutron TAS Taipan is proposed for its future upgrading in order to improve its data acquisition efficiency. The design with 21 analyser channels is sketched and simulated at the two E_f options, 8.07meV and 14.87meV. The simulation indicates that the splitting angle Δ = 2° is a quite good option for both E_f. However, depending on the purpose of the experiment, the splitting angle Δ = 1.5°, 2.0°, and 2.5° are all possible options to achieve the most advantages of the multi-analyser design. A dynamic design for varying the splitting angle will be an option for implementation of the multi- analyser design on Taipan.

Reference

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***E-mails: gc.deng.ansto@gmail.com**